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Description

Injection unit for an injection-molding machine

The present invention relates to an injection unit for an injection-molding machine for processing thermoplastic material, the injection-molding machine having a screw which is guided in a cylinder and the axial movement of which can be initiated by a first motor and the rotary movement of which can be initiated by a second motor, an electrical direct drive being provided as the first motor.

An injection unit of this type is known from DE 43 44 335 A1. In this case, polymer is forced out into a mold by a linear movement of a stationary screw. This operation takes place with a first direct drive. However, material preparation of the polymer has been initiated in each case beforehand by turning of the screw in an assigned cylinder with the aid of a second direct drive.

Direct drives have the advantage of having very good dynamics, one of the ways in which this is manifested being a very short time span to reach the injection speed. However, direct drives entail relatively high costs. This is because it is not only necessary for the motor to be adapted to the geometry of the machine but also to produce a very high torque at relatively low rotational speeds, in order to be adapted to the required injection speed with the desired injection pressure.

In the case of direct drives, both the injection motor and the metering motor have to supply a relatively great torque, which is derived, inter alia, from the injection pressure. The second motor, i.e. the metering motor, only moves, however, at rotational speeds which are significantly below the operationally required rotational

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speed of the injection motor. For example, one possible configuration is to be designed in such a way that the injection motor has to produce a torque of 1000 Nm at a maximum rotational speed of 1000 rpm, whereas the metering motor has to provide a torque of 1000 Nm for a rotational speed of below 300 rpm.

In the case of commercially available machines, it is also provided that the two movements are transmitted by indirect drives, by means of belts or gear mechanisms. The adaptation of the motor torque and motor speed to the requirements of the injection unit then takes place by the respective transmission ratio. In this case, the dynamics for automatic controlling operations are less, however, than in the case of direct drives, but use of standard drives can be made possible by the design of the gear mechanisms.

The object of the invention is to design an injection unit of the type stated at the beginning in such a way that optimum conditions with respect to performance and cost-effectiveness are achieved for the whole arrangement.

On the basis of the perception of the inventors that the dynamic requirements in the case of injection units of the type mentioned at the beginning are indeed very high for the actual injection operation but not so high for the metering operation, the stated object can be achieved by only the second motor being connected to the screw via a gear mechanism, in such a way that the rotational speed of the second motor can be reduced to a lower speed of the screw, adapted to the material-preparing process.

A first advantageous design of the invention is characterized in that the gear mechanism can be blocked

during the operation of injecting the thermoplastic material. This prevents the metering motor from having to supply a torque during injection.

In a technically extremely simple form, this block may be provided as a non-return valve.

An extremely low-cost configuration is obtained by the fact that a belt-pulley gear is provided as the gear mechanism.

The fact that the first motor rotatably moves a spindle, which is connected to the screw, via a displaceably secured spindle nut allows a rotating motor to be used as a direct drive for producing the axial movement in this respect. Consequently, unlike in the case of using purely linear drives, it is possible to fall back on standard components.

An exemplary embodiment of the invention is represented in the drawing and explained in more detail below.

Shown here, in the form of a basic drawing, is a screw SCH, which is mounted axially and rotationally movably in a screw cylinder SZ. The free end of the screw cylinder SZ, facing the actual mold parts of the injection-molding machine, is shown in cut-away section. Similarly, feeding elements for pelletized polymer material, for example, into the interior of the screw cylinder SZ are likewise not shown for the sake of overall clarity. The screw SCH is firmly connected to a spindle SP, on which there is mounted a spindle nut SM which can be set in rotation in a displaceably secure manner by a first motor, i.e. an injection motor EM. In such rotation, with the screw/spindle arrangement secured against displacement, an

axial movement of the screw indicated by a double-headed arrow is initiated, as required for forcing prepared thermoplastic material out of the screw cylinder SZ into the mold, i.e. for the injection operation.

The spindle SP has, furthermore, on its free end a belt pulley RS1, which is connected via a belt R to a second motor, i.e. a metering motor DM. As soon as this metering motor DM is set in rotation, this leads to a reduced-speed rotation of the spindle SP and consequently of the screw SCH. This brings about a thorough mixing of the polymer pellets and, at the assumed ambient temperatures, the thermoplastic material is prepared for injection, i.e. metered. Since a rotation of the spindle SP1 with the spindle nut SM unmoved initiates an axial movement of the screw SCH and of the spindle SP, this movement must be superposed by a rotational movement of the injection motor EM, which ultimately ensures that the prepared thermoplastic material is made available for injection, ready for the production process, only at a desired system pressure in the screw cylinder SZ.

The metering motor DM can be relieved during the injection operation, during which only the injection motor EM is active, by the gear mechanism comprising the belt R and belt pulleys RS1 and RS2 being blocked. Similarly, it should be pointed out that it is advantageous in comparison with the prior art mentioned at the beginning that the metering motor DM is also completely protected by the belt gear mechanism from axial forces, which would otherwise require expensive axial bearings for absorbing the forces. The metering motor DM may be designed as a built-on motor and run with a high rotational speed and a correspondingly great transmission ratio. If, in a way corresponding to the example stated further above, a

torque of 1000 Nm is to be produced at a rotational speed of 300 rpm, a motor with a torque of 100 Nm and a rotational speed of 3000 rpm can be used if there is a transmission ratio of 10 : 1.

In the case of the invention, consequently, an expensive direct drive is used only where the high dynamics which can be achieved with it are actually required. This leads to a decisive cost advantage over the prior art. If an asynchronous motor is used as the metering motor DM, the costs can be further reduced considerably.

A further important aspect of injection-molding machines is the overall length of the installation. The direct drives according to the prior art are arranged one behind the other and therefore contribute to the total length. In the case of the proposed concept, in which the second motor, i.e. the metering motor DM, is realized by an indirect drive, it can be fitted, for example, underneath the unit, thereby reducing the total overall length significantly.